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Respiration and Metabolism in a Young Crocodile (*Crocodylus acutus* Cuvier)

By D. B. Dill and H. T. Edwards

MANY cold-blooded animals have a capacity greatly exceeding that of man for suspension of respiration. The record for man appears to be held by a student of Schneider (1930), who took three deep breaths of oxygen, following a period of forced breathing, and then held his breath for 15 minutes and 13 seconds. Parker (1925) has carried out experiments on the alligator and the cayman and has found that the former can remain under water 5 hours before drowning while the cayman drowns in a little less than an hour.

Some observations which relate to this subject have been made during the past summer at the Barro Colorado Laboratory.[1] A crocodile weighing 490 grams was fastened ventral side up to a table and, under local anaesthesia, the trachea was exposed and a cannula was inserted. After it was established that the connection was air-tight, we were able to change at will the gas in the lungs, to observe its volume and to determine its composition.

Twelve experiments of the following type were carried out. After each of three successive one-minute intervals the air was removed from the lungs with a syringe and the lungs at once well inflated with about 50 cc. of fresh air. This served to bring the crocodile into a fairly uniform condition for each of the 12 experiments. The third portion of air thus introduced was measured accurately with the syringe and the time noted. After a given time interval, which varied from 2 to 25 minutes, the air was withdrawn, its volume noted, and a sample taken for analysis.

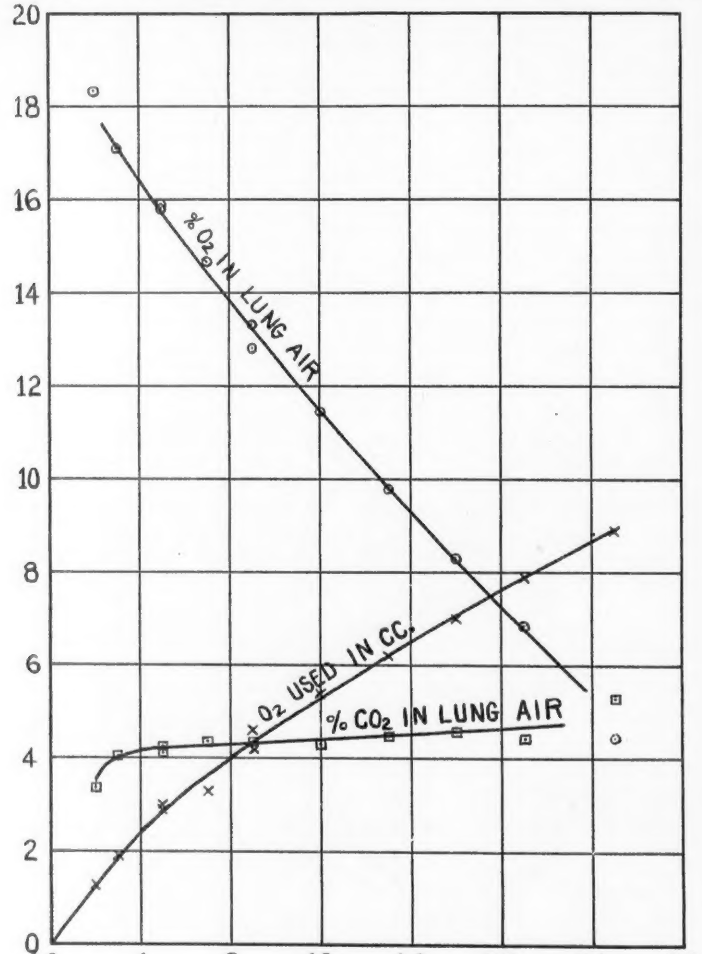
There are some sources of error in this technique but as a first approximation they are of no importance. Thus it was impossible to empty the lungs completely, but by flushing out twice preceding each experiment this error was diminished. It might be supposed that the crocodile may not have remained in a steady state over the series of experiments but the evidence indicates that it did. Thus in Experiment 2, of 5 minutes duration, and in Experiment 7, also of 5 minutes duration but an hour later in the day, the samples of lung air had the following composition:

Experiment	Time A.M.	Oxygen per cent.	Carbon dioxide per cent.
2	10:05	15.90	4.24
7	11:00	15.86	4.10

A further source of error might be due to variation in temperature, but the room temperature (and the crocodile's temperature) remained within the limits, 29° ± 1°C., throughout the series of experiments.

[1] We are indebted to Professor T. Barbour and to Mr. James Zetek, Custodian, for courtesies during our work at the Barro Colorado Laboratory in the Canal Zone of Panama.

The results, shown graphically, indicate that the percentage of oxygen in lung air decreased along a smooth curve to a value of 4.4% after 25 minutes. The values for oxygen consumption take into account the decreasing volume of lung air and it is evident that the rate fell off rapidly



in the longer experiments. The slope of this curve determines the rate. Over the first 6 minutes the rate was equivalent to 66 cc. of oxygen per kilo of body weight per hour while from the 12th to 25th minute the rate was just one-half the initial value.

In a supplementary experiment pure oxygen was used both for the preliminary periods and for the experimental period. The volume of gas was observed occasionally by filling the syringe and immediately returning the gas to the lungs. During the course of 45 minutes the volume decreased in a linear fashion from 51 cc. to 29 cc. and at the end of this period the residual gas contained 7.8% carbon dioxide. These figures correspond to an oxygen consumption of 66 cc. per kilo per hour, precisely that observed during the first 6 minutes when the lungs contained air.

Thus it is evident that lactic acid begins to accumulate in from 6 to 10 minutes after respiration ceases. After 25 minutes, more than one-half the oxygen requirement is met by lactic acid formation, and if one may venture to extrapolate, after about 35 minutes the animal is anoxic except for oxygen which may diffuse through an exposed mucous membrane, such as that in the mouth.

Our observations on the apparent distress of the animals agree with the quantitative evidence and with Parker's observations on the cayman. This crocodile never exhibited distress up to 15 minutes, the distress appeared to be slight up to 21 minutes, but between 21 to 25 minutes it must have been considerable for in contrast to the shorter periods there were many movements, some of them of a convulsive character. In the oxygen experiment there were no signs of discomfort throughout the entire period of 45 minutes, notwithstanding an increase in carbon dioxide to 7.8%. The small increase in carbon dioxide observed up to 21 minutes at first sight appears paradoxical but calculation shows it is quite in harmony with the buffering capacity of the organism for carbonic acid, as recently discussed by Shaw and Messer (1930).

Schneider (1930) has discussed the conditions which limit a man's ability to hold his breath and has decided that increase in carbon dioxide and related variables are of primary importance. In the crocodile the respiratory center seems to be tolerant toward the changes brought about by carbon dioxide accumulation, but its response to anoxemia is qualitatively similar to that of the respiratory center of man.

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Notes on Two Specimens of the Rare Snake *Ficimia cana* and the Description of a New Species of *Ficimia* from Texas

By Edward H. Taylor

I

THE species *Ficimia cana,* described by Cope[1] in 1860 from a specimen collected near Fort Buchanan, Arizona, by Dr. B. J. D. Irwin, has remained a great rarity in collections. Cope, in his *Crocodilians, Lizards, and Snakes,* records a second specimen taken by H. W. Henshaw in southern Arizona in 1873. Ruthven[2] reports a specimen found dead on the shore of Lake Walters at the White Sands, West of Alamogordo, New Mexico, in the summer of 1906. Boulenger[3] lists a specimen from El Paso, Texas,[4] but no date of collection is indicated. Van Denburgh[5] mentions still another specimen from Montezuma Canyon, Huachuca Mountains, Arizona.

The following descriptions are based on two specimens which were collected in New Mexico in 1929 by John Suarez Wright and myself.

Number 6617, Kansas University Museum of Birds and Mammals. Collected by Edward H. Taylor and John Suarez Wright, 10 miles north of Florida, Luna County, New Mexico, August 4, 1929, "about midnight with light." Adult male. Unlike the specimens mentioned by Cope, and shown in his figure,[6] there are two nasal scales separated from the first labial. The "groove from the nostril to the suture of the second labial" is merely the posterior part of a suture between the nasal and the front labial while the anterior part is fused with the first labial in Cope's specimen. In the characters of the internasal, the prefrontals and all the other head scales, the specimen is practically identical with Cope's figure. The dorsal bands on body and head are 39; on the tail 12, each usually continuous, but occasionally broken, always narrowed laterally; on the sides narrow elongate broken spots occur between the bands. The belly is immaculate save for a few flecks of brown on the scales of the posterior part of the body and under tail. The posterior pair of chin shields is so small and separated so widely that one distinguishes them with difficulty. Ventrals 134, subcaudals 35. The anal is divided. Scale rows 19-17. The total length is 178 mm; the tail 48 mm.

Number 6616, Kansas University Museum. This specimen was collected at the same time and place as the preceding. It is a female and not improbably the mate of the male listed above, as it was taken about fifty feet from the other specimen only a few minutes later. In squamation of the

[1] Proc. Acad. Nat. Sci. Phila., 1860: 243 (footnote)—Gyalopium canum.
[2] Ruthven, Bull. Amer. Mus. Nat. Hist., 23, 1907: 587.
[3] Boulenger, Cat. Snakes, Brit. Mus., 2, 1894: 272.
[4] Not Duval County, Texas, as stated by Strecker, Baylor Bull., 18 (4), 1915: 40.
[5] Van Denburgh, Occ. Papers Cal. Acad. Sci., No. 10, Vol. 2, 1922: 779.
[6] Ann. Rept. Nat. Mus., 1898 (1900): 948, fig. 241.

head the two specimens agree, save that a small preocular is present in this specimen. There are 36 bands on head and body; 9 on the tail. Ventrals 143; subcaudals 31. The anal is divided. The total length of the head and body 205 mm.; of the tail, 54 mm.

The male snake when first found remained motionless, perhaps blinded by the light which I carried; but immediately on being touched it began to writhe and to throw its body in strange contortions, as if in agony, sometimes almost throwing itself off the ground. It would continue these actions for several seconds and at the same time it would extrude and retract the cloaca rather rapidly, for a distance of half an inch or more, which resulted in a popping sound. Wright tested the female and found that she reacted in practically the same manner as the male. These tactics were repeated time and again by the two specimens and even when in the collecting sack they continued these strange gyrations and jumping movements, as well as the continued extrusion and retraction of the cloaca.

The terrain where they were found was a large flat, covered with short, very sparse grass, the soil largely free from sand or gravel. A large number of mounds thrown up by rodents (probably a species of *Dipodymus*) were scattered about the terrain. A rain had fallen, probably sometime in the morning, and the surface of the ground was still moist.

II

While collecting in southern Texas in the summer of 1930, I captured a specimen of a small snake which I believe to be an undescribed species of the genus *Ficimia*. It was found three miles east of Rio Grande City along the highway, about midnight of the night of July 13, 1930.

The species belongs to the section of the genus characterized by a recurved rostral forming a broad suture with the rostral and with internasals wanting (or fused with the prefrontals). It is probably most closely allied to *Ficimia olivacea* Gray and *Ficimia publia* Cope.

Ficimia **streckeri**, new species

Type.—No. 4140, Kansas University Museum; adult female; collected three miles east of Rio Grande City, Texas, July 13, 1930, by Edward H. Taylor.

Diagnosis.—Characterized by a recurved rostral, pointed anteriorly, forming a suture as wide as the rostral with the frontal; internasals absent; nasal joined with the first labial anteriorly; nostril pierced near the center of the combined scales from which emerges the suture which separates the posterior part of the scales; seven upper and eight lower labials; body grayish with darker narrow transverse bands; one postocular; prefrontals not extending as far posteriorly as the rostral.

Description.—A small, more or less cylindrical species with snout strongly pointed and recurved; the tip of the rostral when viewed from above forming an angle less than a right angle; the portion of rostral visible above, distinctly longer than wide (2.2 mm. $\times$ 3.2 mm.), forming a

sharp edge anteriorly and medially a sharp recurved point, like a small pyramid, the apex pointed somewhat forward; frontal broader than long (3.2 mm. $\times$ 2.4 mm.), pentagonal, the anterior edge nearly straight, the sides parallel, and forming a very wide angle posteriorly; parietals broader than long (3.5 mm. $\times$ 3 mm.); prefrontals large, forming a small suture with the frontal, in contact their entire length with the rostral, but failing to reach as far posteriorly as the rostral does, anteriorly forming a suture the entire length of the nasal; laterally in contact with the second labial and preocular; internasals absent; preocular pentagonal, touching second and third labials; third and fourth labials entering the eye; one pentagonal postocular forming sutures with the fourth and fifth labials; supraocular somewhat wider posteriorly than anteriorly, less than 1/3 the width of frontal; a single elongate temporal followed by two posterior temporals; seven upper labials, the sixth largest, the seventh well differentiated; eight lower labials, the first three touching the first pair of chin shields, which are somewhat longer than broad; second pair of chin shields touching two labials, smaller than first pair, much longer than broad and separated by a pair of small gular scales; three rows of gular scales separate the chin shields from the first ventral scale; first ventral separated from labials by four rows of gulars; eye small, pupil round; anterior to ninth ventral, 19 rows of scales around body; posterior to ninth ventral, 17 rows of scales; scales smooth, each with a single apical pit; anal divided; two ventrals immediately in front of anal also (probably abnormally) divided; ventral scales 144; subcaudals 30, divided.

Color.—Above dull ash gray, each scale edged with slightly darker gray, the body color extending as far as the outer scale row but growing somewhat less dense laterally; a few minute grayish flecks on the outer scale row; body traversed by 46 transverse, dark, blackish gray bands which reach laterally to the second scale row, the bands averaging one scale length in width, a few of them broken; on sides are occasional small dark spots between the outer ends of the bands; the bands separated usually by four scale rows; tail with eleven bands which are frequently broken; head uniform bronzy gray, slightly darker than body; a suggestion of a small longitudinal darker spot on the parietals on their mutual suture; sides of head lighter; labials mostly whitish with a very indistinct darker area on the fourth below posterior part of eye, and one on suture between the fifth and sixth labials; below uniform paper-white.

Measurements.—Total length 298 mm.; tail 41 mm.; greatest width of head 8 mm.; length of head (to edge of parietals) 7.9 mm., average body width 10 mm.

Remarks.—The elongated rostral; the single postocular; the much shorter, broader, parallel sided frontal; the more strongly recurved rostral; the smaller, more anterior prefrontals; different body coloration, with narrower more numerous transverse bands, and the absence of distinctive head marking of this specimen, seem to warrant its being recognized as a new species.

Whether Boulenger is justified in uniting Cope's *Ficimia publia* with Gray's *Ficimia olivacea* is to be doubted. It is to be hoped that materials of these species that have reached museums in recent years be examined by workers, and the data published with the view of arriving at a better understanding of the forms associated in this remarkable genus.

The present species is named for John K. Strecker of Baylor University, who has made many excellent contributions to our knowledge of Texas faunas.

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Behavior of the Rubber Snake

BY ROLAND CASE ROSS

ACTIVITY TEMPERATURES

THE Pacific rubber snake (*Charina bottae bottae* Blainville) was abundant at 5,500 feet elevation in the canyon bottom of the Stanislaus River, Calaveras County, California, where I camped from June 1 to July 19, this past summer (1930). The region was in the Transition life-zone; the location was a silt filled canyon, called Sand Flat.

Except for cloudy days it was usually 5 P.M. before the rubber snakes were abroad, along the moist forest bottoms, or river sands, or the small sandy islands; after dusk they could still be found. Mornings they seemed to disappear along about 8 A.M. The numerous individuals I kept in cages with two inches of sand seldom were out during the day. They showed greatest activity evenings from late afternoon up to 8 P.M., when they retired at temperatures varying from 52° to 50° F. I never saw one abroad in the cage when the atmospheric temperature was below 50°. Cage sands, being shallow, followed atmospheric temperatures, but soil four inches deep showed a constant cool temperature, being 47.5° at night (June 24th for example) while the surface soil (one-half inch) was 56°, and the atmosphere 51°. I do not believe they retire nightly to such cold depths, though they did go to the bottom of tin cans with 6 to 7 inches of sand.

By 5 P.M., when rubber snakes were freely active, the temperature might be as high as 74° F. It was interesting to see rubber snakes become active at temperatures that made the caged Pacific rattlesnakes inactive; and *vice versa* in the mornings, with the difference that the rattlers did not stir for an hour after the rubber snakes retired. It was impossible to observe temperatures of rattler activity, due to daily absences, but atmospheric temperatures were not so important (to caged specimens) as was the availability of direct morning sunshine.

CLIMBING ABILITY

A female chipmunk making a disturbance and later carrying young from the nest hole caused us to investigate. A boy climbed up the old

and slightly leaning stump and reported a snake in the hole, twelve feet above ground. On felling the stub a large rubber snake was taken from the chipmunk's nest, but there were no baby chipmunks, nor was the snake distended, or freshly bruised. It bore long scars and more bruises than are common for this species which is so frequently, or so usually, scarred. I surmised that its predelection for climbing brought it into more trouble than others more terrestrial in habits. It could not grip a smooth peeled trunk, but upon rough-scaled lodgepole bark this *Charina* had no difficulty clinging: it was not necessary for it to girdle the trunk, but only to zig-zag across one side, or up. The snake was sure of itself, and composed upon rough trunks: it was uneasy upon smooth poles and showed no tendency to twine. Upon a trunk the snake gravitated to the slant side and progressed nicely upwards. When twigs were reached it readily used them, rather lumpily, but surely, and if touched twined readily about them.

Another individual was found upon the ridgepole of a two story frame house under construction and unroofed. I have no doubt *Charina* could climb rough studding, but it could as easily have descended via branches to the frame of the house.

Further evidence of their climbing ability is to be noted in cage habits. Rubber snakes examine even the roof of cages, readily climb side walls by using the corners, and are mysterious escapers. All of which indicates an ability hardly expected from such sluggish burrowing snakes, and yet to be expected from Boidae.

Feeding

Young nursing mice, though pretty big, proved sufficient and satisfying food. I found *Charina* almost instantaneous in striking at times, and quicker to respond to offered prey than rattlers and gopher snakes.

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Notes on Reptiles in the Collection of the Ohio State Museum

By Charles F. Walker

A CONSIDERABLE amount of material has accumulated in the collection of the Ohio State Museum during the past few years which notably advances our knowledge of certain reptiles within the state. There has not been a list of Ohio reptiles published since that of Morse (1904), which is now quite inadequate. The following notes are concerned only with certain of the less common species; three of them were not included in Morse's list. The greater part of the old University collection, on which Morse's paper was based, is still preserved and a few of these specimens are here described in detail for the first time. For the recent specimens thanks are due to a number of collectors. The writer's share has been small and mostly incidental to the collecting of amphibians. The collector's name is given with every specimen mentioned below as is also the Ohio State Museum catalogue number. Measurements are in millimeters.

Carphophis amoena helenae (Kennicott)

76, 1-7—along Ohio River eight miles west of Portsmouth, Scioto County, May 27, 1927; R. W. Franks, Conrad Roth, and J. S. Hine.

These specimens are briefly described here for the evidence they present as to the relationship between typical *amoena* and Kennicott's *helenae,* which is characterized by the fusion of the internasals with the prefrontals. *C. helenae* has long been considered a synonym of *amoena* but has recently been revived as a subspecies by Blanchard (1924). Following Blanchard the present series has been identified as *helenae* although No. 5 is typical of *amoena* and Nos. 4 and 7 are intermediate. From the ranges given the two forms by Blanchard it might be expected that Ohio specimens would show a tendency to intergrade with typical *amoena.* Individuals referable to *helenae* have been reported by Cope (1900) from Monroe Co. and by Morse (1901) from Meigs Co. The latter specimen is no longer preserved.

	Sex	Length	Tail	Ventrals	Caudals	Internasals and prefrontals
76, 1	male	237	45	119	37	fused
2	male	121	20	117	32	fused
3	female	245[1]	..	121	..	fused
4	male	239	40	118	34	fused on left, separate on right
5	male	246	42	114	37	separate
6	male	225	38	115	31	fused
7	female	172	22	127	28	fused on left, separate on right

[1] Tail injured.

Opheodrys aestivus (Linné)

86—Shawnee Forest, Scioto Co.; July 9, 1928; Earl Sanderson. This specimen is a female 605 mm. in length. There are 157 ventrals. The tail has been broken. The snake was kept alive for several weeks and on July 20 laid four eggs which measured 31×11, 29×10, 30×11, 30×10 mm.

87—Green Twp., Adams Co.; Oct. 10, 1928; G. T. Watters. Length, 696; tail, 286; ventrals, 155; caudals, 142; male. The lower labials are reduced to seven on the left side due to the fusion of the most posterior two. The anterior temporal is divided into two scutes of about equal size on the left and is normal on the right.

207—Portsmouth, Scioto Co.; June 29, 1929; R. B. Gordon. Length, 805; tail, 307; ventrals, 156; caudals, 124; female. The anterior temporal is divided on the left as in the previous specimen. There are eight upper labials on the right and the normal seven on the left.

Aside from the variations noted with each specimen these snakes agree closely with the description of *aestivus* as given by Cope (1900). The scale row formula for each is 17-15 with the lower two rows not keeled anteriorly and the lower row only smooth posteriorly.

Lampropeltis getulus nigra (Yarrow)

90—Rock Run, Green Twp., Adams Co.; Apr. 24, 1927; G. T. Watters. This specimen is an adult female. An examination reveals no important variation from the description of the form as given by Blanchard (1921, p. 43). Length, 965; tail, 132; ventrals, 204; caudals, 49. The scale row formula is 19-21-19-17. The back is crossed by about 78 narrow, broken bands. Most of the dorsal scales between the cross bands are black, a very few have small light centers. The only other specimen in the collection is the small one from Lawrence County mentioned by Blanchard (1921, p. 48). The *Check List* of Stejneger and Barbour (1923) neglects to include Ohio within the range of this form.

Natrix kirtlandii (Kennicott)

94—Sugar Grove, Fairfield Co.; Feb. 21, 1926; E. S. Thomas.

This is the only recent Ohio record for the species. Additional specimens in the collection are the three mentioned by Morse (1904, p. 132), No. 38 from Perry Co., No. 39 from New London, Huron Co., and No. 40 from Sugar Grove, Fairfield Co. Since little has been published as to the variations within this species, the scutellation of these specimens is summarized here. The scale row formula is uniformly 19-17; the temporals, 1, 2; preoculars, 1; lower labials, 7.

No.	Length	Tail	Ventrals	Caudals	Postoculars	Upper labials
38	400[a]	..	131	..	2	6
39	302	58	131	46	2,3	6
40	249	50	130	48	2	5
94	394	85	129	61	2	6

[a] Tail injured.

Virginia valeriae valeriae (Baird and Girard)

246—Salt Creek Twp., Hocking Co.; June 8, 1930; Arthur Stupka.

This is apparently the second specimen taken in the state, the only other record being that of Morse (1904, p. 133), whose specimen from Richmondale, Ross Co., No. 55, is fortunately still available for comparison. The two agree in having the scale rows 15 throughout the body length, 6 upper and 6 lower labials, temporals 1, 2. The Hocking County snake shows faint keels on the posterior part of the body; these are lacking on Morse's specimen. Both seem to the writer to be quite typical of *valeriae*.

No.	Sex	Length	Tail	Ventrals	Caudals	Postoculars
55	female	212	28	125	27	2, 3
246	male?	135	21	118	32	2, 2

Blanchard (1923), in his treatment of the genus, has apparently overlooked Morse's record, nor do Stejneger and Barbour (1923) include Ohio in the range of the species.

Agkistrodon mokasen Beauvois

73—Hocking Co.; May 29, 1910; B. B. Fulton.

121, 1-2—Good Hope Twp., Hocking Co.; June 15, 1928; J. S. Hine and C. F. Walker.

120—Green Twp., Adams Co.; July 1, 1927; G. T. Watters.

259—Jackson Twp., Knox Co.; June 15, 1930; E. S. Thomas.

Sistrurus catenatus catenatus (Rafinesque)

117—Richmond Twp., Huron Co.; May 30, 1926; R. W. Franks.

118, 1-2—Richmond Twp., Huron Co.; Aug. 7, 1927; E. S. Thomas and C. F. Walker.

119—near Buckeye Lake, Walnut Twp., Fairfield Co.; Aug. 29, 1928; R. M. Geist and C. F. Walker.

174—near Buckeye Lake, Fairfield Co.; Apr. 7, 1929; J. S. Hine.

The localities represented by these specimens are mentioned neither by Morse (1904) nor by Cope (1900).

Crotalus horridus Linné

122—Jackson Twp., Jackson Co.; July 25, 1926; M. A. Guy.

123—Long Lick, Green Twp., Adams Co.; July 27, 1926; G. T. Watters.

124—Shawnee Forest, Scioto Co.; July 9, 1928; R. C. Sloane.

223, 1-2—Catawba Island, Ottawa Co.; Aug., 1929; W. F. Rofkar.

Mr. Rofkar of Catawba Island is authority for the statement that eighteen rattlers were killed or captured in that locality during the summer of 1929. The Stone Laboratory of the Ohio State University at Put-in-Bay has a specimen taken on South Bass Island. In the southern part of the state the present tendency towards reforestation and the abandonment of agriculture in the hilly country may be favorable for the preservation of this species.

Clemmys guttata (Schneider)

201—near Toledo, Lucas Co.; June, 1929; L. W. Campbell.

242—Swan Creek Twp., Fulton Co.; June 1, 1930; J. S. Hine.

333—Farnham, Ashtabula Co.; July 31, 1928; C. F. Walker.

In addition to these specimens from the northern part of the state there are series of the spotted turtle from Cedar Swamp, Champaign Co., and Buckeye Lake, Licking Co. Evidence of the occurrence of this turtle from any locality in the southern part of the state is lacking and it would seem therefore not to be as generally distributed in Ohio as indicated by Morse (1904, p. 141).

Emys blandingii (Holbrook)

139—Sandy Beach, Ottawa Co.; Apr. 25, 1926; M. B. Trautman and C. F. Walker.

189—near Westerville, Franklin Co.; May 4, 1929; L. E. Hicks.

201—near Toledo, Lucas Co.; June, 1929; L. W. Campbell.

268—Wauseon, Fulton Co.; Sept. 2, 1930; J. S. Hine.

The specimen mentioned by Morse (1904, p. 141) from Sandusky, Erie Co., is still preserved (No. 150), but that from Franklin Co. has disappeared. The Westerville turtle (189) listed above is the only one known to the writer to have been collected south of the northern tier of counties. That the species is native and not accidentally introduced here remains to be confirmed by other specimens. Morse states that it is "found in the larger streams flowing into Lake Erie and the Ohio River" but gives no authority to support his statement. The range of the species as usually given includes no locality as far south as central Ohio.

Pseudemys elegans (Wied)

216—Small pond near Scioto River, Pickaway Plains, Pickaway Co.; Aug. 10, 1929; length of carapace, 168; width, 128; female.

This specimen was taken in a large seine drawn by M. B. Trautman, J. S. Hine and the writer. Another specimen has since been examined, one of six taken by Mr. Elmer Hamiel on a trot-line in the same vicinity. Dr. Stejneger writes that the only specimen known by him to have an Ohio record is the one in the British Museum listed by Boulenger (1889, p. 78) with no definite locality. No other records are known to the writer and it is assumed that the British Museum turtle forms the basis for the inclusion of Ohio in the range of *elegans* as given by Stejneger and Barbour (1923, p. 135). Morse (1904) does not mention the species. That it is well established in the locality where our specimen was collected seems apparent from the number secured by Mr. Hamiel. The pond where No. 216 was taken is rather remotely situated in a broad flood plain of the Scioto River in a region known as the "Pickaway Plains," which was originally a rather extensive prairie.

Amyda mutica (Le Sueur)

142—Muskingum River at Gayport, Muskingum Co.; July 2, 1927; M. B. Trautman and R. W. Franks. Length of carapace, 43; width, 38.

252—small tributary of Scioto River near mouth, Clay Twp., Scioto Co.; July 27, 1929; M. B. Trautman and R. B. Foster. Length, 115; width, 101; female.

253—Muskingum River at Dam 2, Washington Co.; June 29, 1930; M. B. Trautman and R. B. Foster. Length, 144; width, 125; male.

272—White Oak Creek at mouth, Brown Co.; Aug. 17, 1930; M. B. Trautman and R. B. Foster. Length, 234; width, 201; female.

274, 1-3—Scioto River, Scioto Twp., Pike Co.; Sept. 14, 1930; M. B. Trautman, R. B. Foster and C. F. Walker. (1) Length, 159; width, 135; male. (2) Length, 167; width, 142; male. (3) Length, 180; width, 160; female.

Of the seven specimens all but two (272 and 274, 3) show the pattern of lines and dots on the carapace which is characteristic of the young of the species and is sufficient in itself to distinguish them from the more widely distributed *spinifera*. Morse (1904) knew of no Ohio records for this very distinctive turtle. Mr. Trautman, whose work in collecting fishes has been responsible for all of the specimens listed, has called the writer's attention to a reference in which Kirsch (1894, p. 333) records several specimens from the Maumee River system in Ohio. However, Miss Doris M. Cochran writes from the National Museum, where Kirsch's material was deposited, that all of the Kirsch specimens preserved there are identified as *spinifera*. The occurrence of *mutica* in the Lake Erie drainage of Ohio therefore remains to be established. In certain of the larger tributaries of the Ohio River it seems not to be rare.

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Ohio State Museum, Columbus, Ohio.

Observations on an Alligator Lizard

By Frank F. Gander

About June 20, 1930, an adult female San Diego alligator lizard *(Gerrhonotus scincicauda webbii)* was collected alive and placed in a glass-fronted cage for observation. At 8 o'clock on the morning of July 17, fifteen eggs were found in the cage. An attempt to incubate some of these failed.

The principal food offered the captive was meal worms and it ate as many as eight or ten of these in rapid succession. Beetles, grasshoppers, flies, butterflies and a large sphinx moth were also readily taken. One grasshopper over three inches long was quickly attacked, but was not entirely consumed until the big jumping legs had become detached.

On August 2, two very young western fence lizards (*Sceloporus occidentalis biseriatus*), measuring not over 1½ inches from tip of nose to tip of tail, were secured. One of these was dropped into the cage near the alligator lizard and the latter at once grabbed it by the head, crushing it so severely that blood spurted from it. With a few deliberate gulps the prey was swallowed—the tail wriggling vigorously as it disappeared. The second was then placed in the cage several inches from the larger lizard, which at once began to stalk it. The young one made no attempt to flee and in a few seconds it, too, was captured, crushed and swallowed. On several previous occasions I have noticed that small lizards placed in a cage with this large species have disappeared, but have never before actually witnessed lizard feeding upon lizard.

On August 5, an egg of the domestic pigeon was placed in the cage with the alligator lizard which tried repeatedly to get hold of it with its mouth, but without success. The egg was rolled all around the cage. An opening was made in the side of the egg, but the lizard failed to take advantage of it.

On August 6, a full grown male Pacific tree-frog (*Hyla regilla*) was placed in the cage with the lizard and was at once seized. After shifting its hold a few times, the lizard dropped its prey and wiped its mouth on the floor of its cage and evinced other signs of having a disagreeable taste in its mouth. The tree-frog remained quiet for a short time and then began to hop about. The lizard once more stalked it but, as the lizard prepared to strike, the tree-frog raised itself on its toes and puffed itself up. It may have emitted some protective vapor, as the lizard withdrew and showed unmistakable signs of discomfiture. A third time the lizard advanced to the attack, but was once more warded off by the frog puffing up and making itself offensive. After this, the lizard frequently looked at the amphibian but made no further attempts to molest it.

For several days in the middle of August, a silvery footless lizard *(Anniella pulchra)*, was kept in the cage with the alligator lizard, but was not eaten. The larger lizard several times approached the smaller one in a

threatening manner, raising itself on its toes so that the body was well off the floor of the cage and with the head turned sideways until the plane of the mouth was vertical. I did not witness an attack.

On August 19, a day-old roof rat (*Rattus rattus alexandrinus*) was offered to the alligator lizard. The little rat squirmed and squealed under the lizard's nose but, while the offering was tested with the tongue, no inclination was shown to take it.

On August 23, a one-third grown house mouse (*Mus musculus musculus*) was placed in the lizard cage and it was at once attacked, crushed and eaten. This occurred in the early morning and others offered it during the day were not bothered, although some were tested with the tongue.

This lizard's methods in capturing its prey were interesting. Approaching stealthily, it would pass alongside the intended victim, its neck bowed and head turned toward the object of its attentions. After coming within striking distance, which was within an inch or so, the lizard would stand poised for a second and then strike very swiftly for the head. I saw grasshoppers and flies evade this strike altogether, and the tree-frog moved so that it was caught by one thigh instead of by the head. Frequently grasshoppers were caught by the body as they started to jump. Both fence lizards and the mouse were seized by the head and their skulls crushed instantly. Whenever the lizard failed to secure a head hold, it would shift its grip until the desired position was attained. A few grasshoppers were able to escape while the lizard was thus shifting its grip, but were at once recaptured.

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On the Occurrence of a Throat-Fan in the Sand Lizard, *Uma notata* Baird, with Notes on the Adaptive Specializations of the Form

By Charles E. Burt

RECENTLY, upon receiving two large males of the ocellated sand lizard, *Uma notata* Baird,[1] I noticed that both had throat-fans of considerable prominence (see accompanying illustration). This seemed surprising at first, since I had not previously observed the presence of a throat-fan in species of our common western iguanids. A review of the literature shows no mention of this feature in *Uma,* although many workers have observed the strong transverse gular fold which lies immediately behind the median throat-fan. Observation has shown that the operation of the throat-fan of *Uma notata* often seems under the general voluntary

[1] These were kindly presented by Mr. Charles M. Bogert of Los Angeles, who collected one in the sandhills sixteen miles west of Yuma, in Imperial County, California, and the other in a similar habitat ten miles north of Palm Springs, in Riverside County, California.

control of the individual, much as in the lizards of the genus *Anolis.*[2] When the throat-fan is withdrawn, its presence is not superficially evident —a fact which probably accounts for its being overlooked in preserved material.

The appearance of a throat-fan in *Uma* may have considerable phylogenetic significance when all of the facts are known. It would be interesting to determine whether the structure exists in the females of *Uma,* or in any of the lizards of the apparently closely allied genera, *Callisaurus*[3] and *Holbrookia,* as well as to trace its evolution in the family Iguanidae as a whole.

In the shape of the body, specimens of *Uma notata* show remarkable adaptation for life in the sandy areas of the desert. As stated by Van

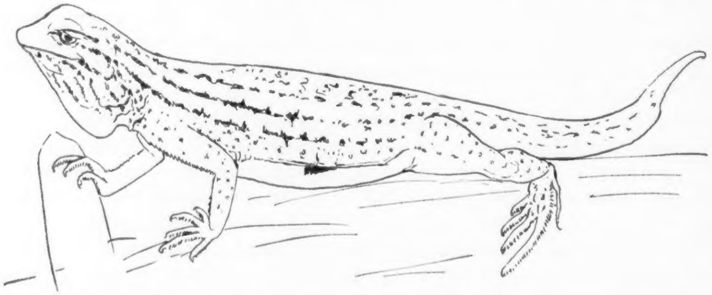

FIGURE 1.—Side view of a large male specimen of *Uma notata* (Univ. Mich., Mus. of Zool., No. 68794) showing the profile of the extended throat-fan.

Denburgh in his *Reptiles of Western North America* (p. 137), "The sharp, depressed snout is evidently a modification for getting beneath the sand." Moreover, the body and tail[4] are both capable of being much flattened through the spreading of the legs and the effective play of the body muscles. This concerted action, and the broken ground color of the back, both tend to render the lizard relatively inconspicuous in its natural habitat, particularly if the body is buried more or less completely in the sand. The two specimens at hand show considerable contrast in dorsal ground color, one being very reddish, whereas the other is much lighter, almost white. This suggests further adaptive specialization—a presumably definite response to variation in the color of the sands of the desert.

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[2] It seems worth while at this point to call attention to the fact that Dr. Charles E. von Geldern has made an excellent study of the "Mechanism in the Production of the Throat-fan in the Florida Chameleon, Anolis carolinensis" (Proc. Calif. Acad Sci., (4) 8, 1919: 313-329).

[3] Van Denburgh (Occ. Pap. Calif. Acad. Sci., 10, 1922: 136) has noted that the habits of Uma are similar to those of the closely related Callisaurus. Likewise, Burt and Burt (Jour. Washington Acad. Sci., 19, 1929: 450) have recently called attention to the fact that the field behavior of Uma notata and Callisaurus ventralis ventralis, which occur in Yuma County, Arizona, in the same habitat, is very similar.

[4] The tail is about three-eighths as high as wide at the base, being six millimeters deep and sixteen millimeters wide in one of my specimens.

The Bullhead, *Ameiurus melas catulus*, as a Dominant in Small Ponds[1]

By Percy Viosca, Jr.

Since artificial ponds, as Cahn[2] has recently shown, offer a profitable field for ecological studies, it is believed that the following observations may prove of interest to ecologists and other students of aquatic biology. Since the year 1917, the Southern Biological Supply Co., Inc., has maintained on the outskirts of New Orleans, a pond, excavated in muck soil with an alluvial clay base. This is used for the storing or rearing of alligators, pond turtles, bullfrogs, crayfish and some other species. It is the opinion of the author that, while not in the nature of a prearranged experiment, these results are almost as if such were the case, since the pond to be described is thoroughly artificial, only a relatively few species were in competition, all of consequence were originally introduced or the date of subsequent introduction known, and the pond was under observation after reaching stability for a long time both before and after the introduction of the bullheads.

The dimensions of the pond are 50x200 feet, with an average depth of about 18 inches, but varying from about 10 inches to nearly 5 feet. There is a seasonal fluctuation and the water level must be maintained by irrigation during drouths. The pond and adjacent shores are partitioned off into a number of separate pens, the water areas being inter-connected through ½ mesh hardware cloth screens.

The entire pond was originally stocked with crayfish, *Cambarus clarkii*, and top minnows, *Gambusia patruelis*. These two species, and tadpoles of the bullfrog hatched from eggs laid in the frog pens, had access to all pens, the crayfish and tadpoles getting through the wire screens only when young. *Sagittaria* was planted throughout the pond. This was kept under control by the crayfish but sprang up fresh every summer during the burrowing season of the crayfish. Any other plants that may have made their way into the pond were no doubt exterminated by the crayfish which flourished wherever not kept down by the other creatures. The *Gambusia* seemed to flourish in all pens, and the tadpoles in all but the alligator pens.

Alligators dominated their pens, exterminating the crayfish and tadpoles each year after the latter individuals became too large to permit restocking through the screens. While these reptiles were heard and seen snapping at the *Gambusia,* particularly at night, there were always other top minnows to enter through the screens to take the place of any that may have been destroyed. In fact, the alligator pens were a prolific source of *Gambusia* food, for Entomostraca thrived there, no doubt because of the excrement from the alligators, and the decomposition of blood or remnants of food, largely fish, thrown to them.

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[1] Contribution from the Research Department, Southern Biological Supply Co., Inc.
[2] Cahn, Alvin R.; The effect of Carp on a small Lake: The Carp as a Dominant. Ecology, 10 (3), July, 1929.

In the pens containing turtles, usually two or three species of *Pseudemys,* the *Gambusia* and tadpoles seemed to maintain a fair balance, but the crayfish did not thrive, although they fared better than in the alligator pens. To what extent the turtles preyed upon them could not be determined, but there was certainly competition for the food supply, both water and shore line plants being exterminated by the turtles, and even the land grasses were bitten off down to the roots. Because of the large number of turtles usually kept in a pen, there undoubtedly must have been much mechanical injury to the crayfish, especially during and after ecdysis.

In the pens containing bullfrogs, the crayfish were kept under control but not exterminated, since a sufficient number of adults survived the summer burrowing season, to restock the pond during the fall, when the young are born. The bullfrogs could not destroy their tadpoles which usually kept away from the shoreline, but during and after transformation the baby frogs were completely annihilated. The top-water minnows seemed to survive in numbers, yet no doubt many were swallowed when they ventured into shallow water at the shore line, although it is usually very difficult for frogs to catch fish.

In pens without the larger creatures, the minnows, crayfish and tadpoles seemed to maintain a balance, with a relative numerical abundance in the order named, all three however were actually present in large numbers. It was estimated that in the whole area something like 10,000 tadpoles grew to large size annually, being either seined out as needed, or reaching the transformation stage. The young crayfish were usually even more abundant, but of course did not survive in the frog and turtle pens, to the extent that the tadpoles did.

On April 15 and 16, 1927, 14 inches of rainfall was recorded within twenty-four hours at the New Orleans office of the Weather Bureau, crippling the city pumping system and leaving about 12 inches of water covering the property of the Biological Company. Small numbers of warmouth bass, *Chaenobryttus gulosus,* and bullheads, *Ameiurus melas catulus,* both of which are present in ponds and canals on the outskirts of the city, entered the last section of the pond which was not under fence at the time.

By the fall of 1927, large numbers of young catfish were observed. During 1928, the whole ecological picture was changed. The crayfish were on the verge of extermination, and it is doubtful if more than a few of their young escaped the catfish, and while the frogs spawned as usual, there was no tadpole crop. The top minnows were reduced to a mere remnant of their former abundance, certainly not more than 5 per cent. The water was constantly roiled and the sagittarias disappeared, probably because of lack of sunlight, in all but one very shallow area which the catfish did not frequent. Except in the turtle pens, *Alternanthera, Polygonum* and *Jussiae* grew out from shore and became pests, there being no crayfish to keep them under control.

The alligators tried to feed upon the bullheads but usually released them when the rigid spines stuck in their tongue or palate. The turtles were evidently neutral, and the catfish congregated more in those pens than in any others, evidently scavenging upon the turtle excrement. The

frogs, of course, could not catch the bullheads which usually remained on the bottom and away from the shoreline. All of the penned animals were thus deprived of their natural food supply and extra food had to be brought in more frequently, but always with a resulting increase in catfish.

An interesting phenomenon was observed at night, when the lights were turned on to attract insects for the frogs and other creatures. The catfish soon learned to congregate under the lights and hundreds of sucking mouths were turned upward at the surface. Whenever a moth or beetle hit the water and a frog leaped at it, he got nothing but a mouthful of water for his pains, the insect having disappeared into one of the "vacuum cleaners" below.

During the spring of 1929, 100 large-mouth bass fingerlings (*Aplites salmoides*) were placed in the pond as an experiment. In November, 1929, while seining for frogs, hundreds of catfish, varying in size from 3 to 10 inches, were removed and destroyed. In January, 1930, it was decided to dry out the pond, a gasoline motor and pump were secured for the purpose, and the pond was drained completely on January 15th. The catfish were seined in the pools and after removing all other animals the entire pond was heavily limed. About 50 gallons of catfish containing approximately 3500 specimens were removed. Adding to these the numbers removed the previous month by seining, it was estimated that about 5000 catfish must have been the population of the pond. There were also about 200 warmouth bass, mostly young or dwarfed specimens, and none of large size. These, it must be remembered, were introduced at the same time as the catfish and had ample chance to propagate. There were 11 large-mouth bass, of uniform size, 7½ inches in length and weighing about ¼ lb. each.

Of the original life of the pond, there was perhaps a thousand or so of *Gambusia,* about two dozen crayfish, and two bullfrog tadpoles. A few crayfish were probably still hidden in their burrows, although they have mostly taken to the water at that time of the year. The catfish certainly dominated everything strictly aquatic and it can be roughly estimated that each catfish took the place of two tadpoles, two or more crayfish and several of *Gambusia.*

Another interesting fact was that in two pens in which the bottom had been covered with clean sand there were very few catfish and in these practically all of the crayfish survivors were found, although the species, *C. clarkii,* is not normally an inhabitant of sand bottomed ponds.

Summary

Observations on the aquatic life, top minnows, crayfish, tadpoles, sagittarias, introduced into an artificial pond used for storing bullfrogs, turtles and alligators were made during periods of relative stability, both before and after the accidental introduction of bullheads. The bullheads soon became a dominant, practically exterminating the strictly aquatic life, even preventing the development in numbers of two important native game fish, the warmouth and the large-mouth bass.

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Notes on the Sound-Producing Marine Fishes of Louisiana

By Martin D. Burkenroad

I

DURING the winter and summer of 1929-30, the writer, working in the field with the fishermen of the Louisiana coast, was afforded considerable opportunity to collect the fishes ot the coastal waters. A number of the species were found to be capable of producing sound. Since aquarium facilities were lacking, notes were made on the vocal species as they were taken alive from the hook, seine or otter-trawl; a few of the fishes were kept under observation for a time in water-buckets or other small containers. These observations were supplemented by the examination of preserved material. At no time did the writer hear any vocal sounds attributable to fishes uncaptured and undisturbed. He is therefore unable to offer any evidence as to the function of vocalization, except to point out that, whatever other conditions call forth the production of sound by fishes, those stimuli attendant on capture and handling seem to excite noise-making in fishes capable of it. The major exceptions to this rule which he has noted are among the batrachoidids: not a single individual, among nine of *Porichthys porossissimus* and among several of *Opsanus tau* observed, made the swim-bladder noise of which these fishes are reported to be capable (Tower, 1908; Hubbs, 1920; Greene, 1924). It must be noted, however, that a certain number of the individuals of each of the species which usually produce sound on capture did not do so. The sounds produced on capture by vocal fishes, i.e., those possessing organs apparently specially adapted to the end of sound-production, did not seem to the writer to be produced involuntarily during the convulsive undirected contractions of all the muscles, as has been the impression of some observers (Sørensen, 1894). The fishes, in the intervals between flurries, often remained perfectly passive except for respiratory and sound-producing movements; fishes held firmly in the hand, making no struggle, usually became exceedingly vocal. It seems probable that such fishes are excited to produce sound in response to stimuli in their natural environment, which are comparable with those supplied by capture by man, and that this response, only in the special case of capture by man, becomes of no apparent adaptive value.

II

Several fishes were observed which do not seem to have been previously described as sound-producing.

1. The first of these, *Hyporamphus unifasciatus,* belongs to an order, the Synentognathi, of which no members have been previously recorded as vocal. Only one individual was observed. This animal produced a fairly

loud, cricket-like stridulatory sound whenever it was lifted from the water of its container, apparently by the scraping together of the rapidly vibrated pharyngeal patches. These patches are opposable, and are covered with small, hard, firmly set teeth. The vibration of the pharyngeal region was synchronous with the production of the sound.

2. The second of these undescribed forms, *Chaetodipterus faber,* is referred to the family Ephippidae, which is grouped with the Chaetodontidae in the suborder Squamipinnes. A chaetodont fish, *Holacanthus,* has been described on morphological grounds, as probably being capable of producing sound (Sørensen, 1894). The swim-bladder of individuals of *Chaetodipterus* of all sexes and sizes is provided with a thin red patch of muscle. A faint drumming noise is produced by fishes of this species, apparently through the agency of the swim-bladder and its intrinsic muscles. The thin-walled sack extends anteriorly almost to the base of the skull, ending in two short caeca. At its posterior end are two long, tubular caeca, which extend backward for some distance behind the visceral cavity. The swim-bladder, which lacks internal partitions, is loosely attached to the dorsal body wall. The deeply colored muscle is compact, flat and broad. It is very firmly attached to the ventral surface of the posterior half of the swim-bladder, and extends dorsally a short distance on the sides, and posteriorly a short distance out on the caeca. This patch of muscle can be observed to vibrate as the sound is produced, in a fish whose belly has been opened. If the swim-bladder is cut open, sound production ceases, although the muscle may continue to vibrate. In addition, a few specimens of *Chaetodipterus* produced a grating croak by the scraping together of the upper and lower patches of pharyngeal teeth.

3. *Syngnathus louisianae* was observed to produce a click quite similar to that of an elaterid beetle, by repeatedly snapping the head very sharply up.

4. *Lagodon rhomboides* produced a scraping clash by the sliding on each other of the upper and lower incisor teeth. The noise is made during a peculiar sneeze-like violent gasp interpolated occasionally among the usual respiratory movements of the fish kept out of water. It is not at all certain that the sounds produced by *Syngnathus* and *Lagodon* are anything but the incidental and involuntary accompaniments of actions directed to some function other than the vocal.

III

A number of species were observed, which are closely related to other, previously described sound-producers, and which agree with them in their method of vocalization.

1.—A number of carangids produce a stridulatory sound, a harsh, almost continuous croak, by scraping the upper and lower pharyngeal patches together. *Chloroscombrus chrysurus* and *Vomer setapinnis* may be added to this list. *Caranx hippos* makes a similar noise, as has been noted by Bridge (1904). Individuals of this species whose swim-bladders were deflated produced a fainter, dryer noise than did normal ones; it is therefore probable that in this carangid, the swim-bladder acts as a resonator for the

stridulatory sound, in the same way that it does in the haemulids (Burkenroad, 1930).

2.—*Spheroides nephelus,* down to very small sizes, and *Chilomycterus spinosus,* in agreement with other gymnodonts (Tower, 1908), produce a stridulatory sound by the grating of the incisor teeth. The sound, in the individuals observed by the writer, was a high-pitched, nasal, whining scrape, produced during and after inflation.

3.—In common with other sciaenid species previously reported as sound-producers, the males of *Cynoscion arenarius, Stellifer lanceolatus* and *Larimus fasciatus* make a drumming noise by means of the air-bladder and its extrinsic muscles.

4.—The triglids *Prionotus tribulus* and *P. punctatus* (?) produce the grunt described for other species of the family, by the action of the intrinsic muscles of the swim-bladder.

5.—The batrachoidid *Porichthys porossissimus,* which, as noted above, was never observed by the writer to produce any sound, possesses a swim-bladder—intrinsic muscle apparatus similar to that described for the species *notatus* of the Pacific coast by Hubbs and Greene, and is no doubt similarly capable of sound production.

6.—*Galeichthys milberti* seems to agree with other siluroids (Dufossé, 1874; Sørensen, 1884, 1894) in its manner of sound production. The writer has observed this species to make a dull, low-pitched grunting noise, which seems to come from the air-bladder. Synchronously with the grunt, a small area of skin just back of the cranial bones on each side of the dorsal median line can be seen to be in very rapid vibration. On dissection, the swim-bladder is found to be heart-shaped, with the apex posterior. It is divided into an anterior and a posterior chamber by a transverse partition which is incomplete laterally, so that the anterior and posterior chambers communicate by two narrow openings. The posterior chamber is further subdivided by a median longitudinal, and by two pairs of incomplete sagittal, partitions. The slender pneumatic duct opens on the middle of the ventral wall of the anterior chamber. The dorsal wall of the swim-bladder is firmly attached, in the region of the juncture of the anterior transverse and the longitudinal partitions, to the vertebrae. The middle of the anterior face of the swim-bladder is attached to a rounded, peg-like vertebral projection. In close contact with the wall of the air-bladder, and loosely attached to it, across its convex anterior face, are two broad tendinous bands. The median ends of these are attached to the peg-like projection, while their outer ends are attached on each side to a springy, curved, slender, bone, the base of which is a flat, thin sheet of bone expanded along the dorsal surface of the body cavity. On the dorsal surface of these bony plates are inserted short muscle fibers, the axis of which is dorso-ventral, and which originate on the posterior cranial bones and the thick dorsal skin. It is the vibrations of these muscles which may be seen as the grunting noise is produced. This apparatus would appear to be an "elastic spring" mechanism essentially similar to that described for other siluroids by Sørensen (1884), and to it, probably, can the "grunt" of this fish be ascribed; however, this conclusion has not been checked experimentally.

In addition, *Galeichthys* makes a second noise, often concurrently with the first; a whining mew apparently produced by stridulation at the articulation of the bony ray of the pectoral fin. Sørensen, in connection with this phenomenon as observed by him in other siluroid species, states that the pectoral spine is fixed in position as a defensive weapon by the friction of an arched crest of its base against the adjacent "scouring faces" of the articulation. He believes that the "brake-like" action as the spine is moved to various defensive positions incidentally causes the sounds, which, however, he thinks may have a secondary function in frightening the assailant. Thilo (1896), with whom Sørensen (1896) disagrees, while not mentioning sound production, believes that the arched crest (designated by Sørensen as δ) is a portion of the diarthrosis of the joint. Thilo believes that the essential portion of the defensive locking mechanism is a prop-like projection (*Hemmfortsatz*) of the base of the spine; Sørensen, on the contrary, believes this peg, which he designates as β, to be a part of the diarthrosis. Dufossé (1874), has described the base of the pectoral spine of a siluroid both as a sound-producing and as a locking mechanism. The structure and action of the pectoral spine of *Galeichthys milberti* seems to be similar to that of other siluroids described by previous workers.

The writer wishes to point out the bearing of the defensive behavior of *Galeichthys milberti* on the controversy outlined above. In this species, the pectoral spine appears to have but a single defensive position: When the fish is roughly handled, the spine is swung forward as far as it will go, and there, standing at right angles to the body-axis, locked into place. At other times, captured catfish kept the pectoral spines in rapid to-and-fro motion, at which time the mewing sound was produced. A strong stimulus promptly caused the locking reaction; the spine was always fixed into place at the extreme forward end of its range of movement. The noise ceased with the cessation of the movement of the spine. The fixing of the spine in the defensive position seems to be accomplished in this way: If the spine is rotated counter-clockwise, that is, in such a way that its anterior edge is pulled ventrally, the peg (*Hemmfortsatz*, β) fits into a socket in the articulating bone in such a way that it acts as a prop. The spine can now be moved forward, but not backward. The crest (δ) is essential to this process in that it acts as a guide, and prevents the peg from lifting out of its socket when pressure is applied to the spine. If, on the other hand, the rotation of the spine is reversed, the propping peg is lifted from contact with its socket, and the spine can be moved backward, but can not be moved forward very freely. This is because of the friction caused by the scraping of the crest against the walls of its runway-like socket. In what may be called the neutral position of the spine, with regard to rotation, both crest and peg seem to act as part of the diarthrosis, and the spine can move freely in either direction. Thus, the only way in which the spine can be immovably erected is by bringing it forward to the end of its range, at the same time rotating it counter-clockwise. It is thus stopped from moving forward by striking the bony anterior wall of the articulation-cavity, and from moving backward by the propping action of the peg. This is, as the writer has pointed out, the defensive position of the spine of living

fish. It therefore is probable that the friction of the crest against the articulating surface, when the spine is rotated clockwise, is not adapted to defensive fixation of the spine, but solely to sound production. Along the lateral contact surface of the crest are a number of fine vertical striations which are thus probably to be considered as stridulatory ridges. For this species, at least, it would seem that Sørensen's belief that sound is produced incidentally to the defensive fixation of the spine, does not hold. *Felichthys felis* appears to be similar to *Galeichthys* in its sound-producing apparatus.

IV

Two groups of fishes, while previously reported as sound-producing, appear to make sounds by means other than those previously ascribed to them.

1.—*Monacanthus hispidus*[1] was observed to produce a sharp, whining, scraping noise by sliding the biting edges of the lower incisors upward over the sloping posterior surfaces of the upper incisors during the rapidly repeated closing of the mouth. The posterior surfaces of the two median pairs of upper incisors of the inner series are striated with a number of fine transverse ridges, which are not present on any of the other tooth surfaces. These are certainly to be considered stridulatory ridges. The possession of such specially modified stridulatory surfaces on the teeth does not appear to have been previously noted in fishes.

2.—Certain sciaenids, which also produce sound by means of the swim-bladder and drumming muscles[2] produce a second kind of noise, often concurrently with the first, by pharyngeal patch stridulation. Individuals of *Micropogon undulatus,* of both sexes, make a loud drumming noise by means of the swim-bladder apparatus. Individuals of this species, in addition, produce a croak like that of a haemulid by the friction of the patches of pharyngeal teeth. The two parts of the upper patch are turned inward toward each other, and drawn backward over the lower patch. No differences were observed between the sexes in the production of this sound. The males of *Stellifer lanceolatus* make a faint drumming noise with the swim-bladder apparatus. Both sexes produce a croak similar to, but fainter than that of *Micropogon,* by pharyngeal stridulation. It seemed to the writer that the females of this species, voiceless as far as "drumming" was concerned, produced the "croak" more readily and persistently than did the males. A number of individuals of *Bairdiella chrysura,* especially the small ones, croaked with the phryngeal teeth. The male of this species drums with the swim-bladder and its muscles.

None of the other sciaenids observed ever croaked with the pharyngeals. These other species are *Cynoscion nebulosus, C. nothus* and *C. arenarius, Leiostomus xanthurus, Larimus fasciatus, Sciaenops ocellatus* and *Pogonias chromis.* In all of these the male drums with the swim-bladder apparatus. *Menticirrhus americanus* appears to be completely voiceless. The pharyngeal patches of *Micropogon, Stellifer* and

[1] Fishes of this genus have been previously described as producing sound by means of the swim-bladder, and by dorsal spine stridulation, neither of which methods was used by this species.

[2] For a description of this phenomenon, see Smith (1905) and Tower (1908).

Bairdiella are thickly set with short, hard, firmly set teeth, presenting an even surface which, when scraped with a hard object, makes a noisy, scratchy sound. The pharyngeal teeth of the species of *Cynoscion* are very similar, except that a few teeth are longer than the rest. The pharyngeal patches of *Larimus* present a softer surface which does not scrape very noisily. The pharyngeal patches, or parts of them, of *Leiostomus* and *Pogonias* are set with flattened, pavement-like teeth. Those of *Sciaenops* and *Menticirrhus* are sparsely set with long, strong teeth. The upper and lower patches of all of these fishes are opposable. The pharyngeal teeth of all of the sciaenids which do not use them for sound production, except, perhaps, the last two mentioned, certainly appear as if they might be so used; in fact the sound made by *Pogonias* was formerly attributed to the friction of its pharyngeal teeth. Nevertheless, these fishes do not make any movement of their pharyngeal patches, under conditions which cause the first three stridulating species listed above to move the patches over each other. The writer, therefore, is inclined to believe that the movement of the pharyngeal teeth of *Micropogon, Stellifer,* and *Bairdiella* represents a modification of the more usual scaenid behavior, the end of which is the production of sound.

Sørensen (1894) makes the statement that it is probable that nearly all fishes are able to make a noise by "gnashing their teeth," and seems not to attach any significance to this as a method of sound production. The writer wishes to point out that tooth-stridulation is no more universal among the fishes he has observed than is vocalization by any other means. While the teeth of many fishes which employ them as sound-producing organs do not seem to be specially modified to this end, they are so modified in some forms, as *Monacanthus*. Also, the modification of behavior attendant on sound-production by "gnashing of the teeth" must certainly, as is pointed out by the differences in this respect among the sciaenids, be regarded as being as significant as is a morphological adaptation.

The writer wishes to call attention to the fact that one sciaenid of those observed by him, *Pogonias,* is exceptional in that it has drumming muscles which are completely attached to, and confined to, the swim-bladder. Tower (1908) seems to have overlooked this fact, since he states that the drumming muscles of sound-producing sciaenids are only superficially attached to the swim-bladder. Tower concludes that this type of apparatus is adapted to producing a rapidly repeated series of grunts. He contrasts with the sciaenid apparatus that of the sea-robin and the toad-fish, with the swim-bladder of which the sound-producing muscles are intrinsically connected, and concludes that this latter type of apparatus is adapted to producing single grunts, not rapidly repeated. Since the muscle of *Pogonias* is intrinsic to the swim-bladder, while the fish nevertheless produces a rapidly repeated series of grunts, the writer believes that no general validity may be accredited to Tower's conclusions.

One Louisiana fish, *Orthopristis chrysopterus,* has been mentioned by the writer (1930) in a previous paper in COPEIA. This haemulid makes a croaking noise by the grating together of its pharyngeal teeth; the swimbladder probably acts as a resonator, as in other haemulids.

If the twenty-five sound-producing fishes discussed in this paper are arranged in taxonomic order, it can be seen that the manner of sound production shows no very clear relation to taxonomic grouping, although the list is perhaps suggestive. Each family has its own typical method of vocalization, which may accord with that of related families.

1. *Nematognathi.* Two vocal species. Swim-bladder—elastic spring apparatus, and pectoral spine stridulation.
2. *Synentognathi.* One species. Pharyngeal stridulation.
3. *Acanthopteri.*
   - A. *Scombroidei.*
     - a. *Carangidae.* Three species. Pharyngeal stridulation.
   - B. *Percoidea.*
     - a. *Haemulidae.* One species. Pharyngeal stridulation.
     - b. *Sciaenidae.* Ten species. Swim-bladder—ex- or intrinsic muscle apparatus, and pharyngeal stridulation.
   - C. *Squamipinnes.*
     - a. *Ephippidae.* One species. Swim-bladder—intrinsic muscle apparatus, and pharyngeal stridulation.
   - D. *Sclerodermi.*
     - a. *Monacanthidae.* One species. Incisor tooth stridulation.
   - E. *Gymnodontes.*
     - a. *Tetraodontidae.* One species. Incisor tooth stridulation.
     - b. *Diodontidae.* One species. Incisor tooth stridulation.
   - F. *Craniomi.*
     - a. *Triglidae.* Two species. Swim-bladder—intrinsic muscle apparatus.
   - G. *Haplodoci.*
     - a. *Batrachoididae.* Two species. Swim-bladder—intrinsic muscle apparatus.

In only one group, the Sciaenidae, is there any sexual differentiation of sound-production. In three groups—the Sciaenidae, the Ephippidae, and the Siluridae—we find the same fish producing sound by more than one means.

Summary

1. Capture by man of sound-producing fishes is probably to be regarded as a stimulus to sound production similar in effect to some stimulus provided by the normal environment, to which the response of the fish is adaptive. Sound production in many fishes probably has a defensive function.

2. Sound production in *Hyporamphus unifasciatus* and *Chaetodipterus faber* is described.

3. Sound production is described in a number of fishes closely related to other, previously described, sound-producers. It is pointed out that the sound produced by the movement of the pectoral spine of *Galeichthys milberti* is not to be regarded as merely incidental to the defensive fixation of the spine.

4. Methods of sound-production not previously described for these forms are noted in *Monacanthus hispidus* and certain sciaenids.

5. The importance of the teeth as sound-producing organs of fishes is emphasized.

6. It is pointed out that the drumming muscles of one sciaenid, *Pogonias,* are intrinsic to the swim-bladder.

7. Twenty-five sound-producing fishes of Louisiana are classified. The list suggests that sound production has arisen independently in the different groups.

Acknowledgments

Mr. Isaac Ginsburg, of the U. S. Bureau of Fisheries, to whom I am also indebted for the means of collecting a quantity of the material, has kindly identified a number of fishes.

Mr. C. M. Breder, Jr., of the New York Aquarium, who suggested a study of the pharyngeal teeth of sciaenids as sound-producing organs, has been kind enough to read and criticize the manuscript, as has also Dr. J. E. Lynch of Tulane University and Dr. Carl L. Hubbs of Michigan. Some of the work was done while the writer was a guest of Dr. E. H. Behre, directress of the Louisiana State University Summer Laboratory, to whom he wishes to express his appreciation. The writer wishes to thank Dr. E. S. Hathaway, of Tulane University, and the personnel of the Department of Conservation of Louisiana for the facilities extended by them.

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Division of Research, Department of Conservation of Louisiana, New Orleans, Louisiana.

Ichthyological Note

A NEW RECORD OF THE CUSK EEL, *OTOPHIDIUM WELSHI* NICHOLS AND BREEDER.—*Otophidium welshi* Nichols and Breeder, described by these authors in the "Proceedings of the Biological Society of Washington," Volume 35, 1922, p. 15, fig. 3, and listed by Breeder in "Field Book of the Marine Fishes of the Atlantic Coast" as "a rare form from the coast of Texas," has been taken off Breton Island, Lousiana.

In November, 1930, two specimens 175 mm. in length were caught in a trawl in about 3 fathoms of water on a sandy bottom. The fish were at first thought to be *Rissola marginata* (DeKay) but differed in the presence of an opercular spine and the peculiar structure of the head and neck. They were sent to Mr. N. Borodin, Curator of Fishes, Museum of Comparative Zoology, who kindly identified them as *Otophidium welshi* Nichols and Breeder.

In December, 1930, 4 more were taken singly in a trawl about 10 miles north northeast of Pass a Loutre, Louisiana, in 8 fathoms of water on a muddy bottom. Some of these later specimens seemed to be somewhat larger than those taken in November near Breton Island, but unfortunately this could not be verified for the barrel containing all the fish material was lost overboard in heavy seas.—Morrow J. Allen, *Biloxi, Mississippi.*

Herpetological Notes

HEMIDACTYLUS MABOUIA (MOREAU DE JONNÈS).—I was fortunate in securing twelve specimens of this lizard, reportedly rare on Porto Rico, at Humacao on November 2, 1930. They were hidden behind a pipe which ran along a white, brightly lighted wall. Occasionally one would dart out from its hiding place to seize an insect which had alighted.

Some of the males have alternating pale orange and black rings around the tail. The amount of dark marbling varies, but in general it consists of a series of about six dark blotches from the occiput to the sacrum, seven on the tail, and two irregular lines of dark spots on each side of the median. All scales except those under the throat are speckled with minute black dots; the darker marbling is due to a greater concentration of the dots. The skin is white with yellow markings usually around the head, the shoulder and the pelvic girdle. The combination yields a decidedly quartz sand color, a lighter yellow in some cases and a darker in others. The tubercles, except on the head, and the spines are keeled. There are about eight rows of tubercles from the midline to the side where the imbricated belly scales commence abruptly. The tubercles on the legs are also arranged in rows.

Two specimens were taken at San Juan and one at Rio Piedras. The gecko from the latter locality is peculiar in its markings. The dark spots form complete rings which enclose smaller spots. There are four of these from the nape to the sacrum. Three on the tail are modified into encircling rings.

In giving these observations I have noted only the characters of interest in comparison with the specimen described by Stejneger.— CHAPMAN GRANT, MAJOR *65th U. S. Infantry, Porto Rico.*

AN ALBINO SALAMANDER.—In the spring of 1927 a friend of mine found a small, albino salamander among the usual mouldering debris on the slope of a wooded hill in Monroe County, Indiana. The specimen was immediately preserved, but until just recently it had not been brought to my notice, thus the more specific data of habitat and environment have been lost.

It is undoubtedly a young individual of *Plethodon glutinosus* and agrees in detail with that species except in the matter of pigmentation. The total length is 62 mm.; the costal grooves are 14 on each side and normal; naso-labial groove well developed; vomerine and parasphenoid teeth quite similar to those of the typical *P. glutinosus.* It apparently is not stunted or morphologically abnormal in any way whatsoever. There is, however, no trace of dark pigmentation on the ventral surface, which is immaculate white. There is a generous sprinkling of greyish upon most of the dorsal region, especially pronounced on the top of the head. It does not extend laterally to any great degree and is distinctly sparse upon the tail. The fore and hind limbs, with the exception of the posterior portion of the latter, are likewise immaculate light. What dark pigmentation there is, however, resembles in no way that of the normal type and is only an obscure sprinkling. I have found smaller specimens of *Plethodon glutinosus* inhabiting caves and never did they portray the slightest deviation from type in the coloration as might possibly be expected from being reared in such an environment. Extensive search has failed to reveal other individuals of this albino character although the typical *glutinosus* is found in great abundance all through Monroe County.

In lieu of the fact that albinism in amphibians is not an uncommon occurrence (Alvin R. Cahn, COPEIA, No. 151, 1926: COPEIA, 1930, No. 1: 18) the discovery of this specimen is in no way unusual, but for this particular species I have been unable to find any previous record of albinism. It would appear to me, since I have hunted this territory systematically for years and my friends' intensive search has revealed no other albinos, that the digression from the customary pigmentation in this individual might possibly have its cause in some freak of environment or extraneous influence rather than an innate anomaly in the genes as the geneticists and zoological theorists of today would have it. I do not dogmatize, I simply suggest the fact. The time is at hand, I think, when we shall be forced to modify our evolutionary concepts and treat the postulates of Lamarck with considerable deference.—JEAN PIATT, *Butler University, Indianapolis, Indiana.*

[1] U. S. Nat. Mus., Ann. Rept. for 1902, 1904: 599-602.

Editorial Notes and News

The Philadelphia Meetings

THE 1931 meetings of the Society are scheduled to be held at the Academy of Natural Sciences of Philadelphia, at 19th and Race Streets, on May 11 to 14. The arrangements are in charge of a Local Committee, consisting of Messrs. Fowler, Dunn and Green. In the business meeting, called for 10 A. M. on Monday, May 11, there will come up for discussion the matter of support of Biological Abstracts and Zoological Record, as outlined below, and other items of importance. Sessions for the reading of papers will be held on Monday and Tuesday. Papers of interest to aquarists will compliment an exhibit by Philadelphia fish fanciers. An excursion to the Philadelphia Aquarium and the Philadelphia Zoological Gardens is proposed, as is also a dinner at Haverford College. Hotel Vendig, at 13th and Filbert Streets, is suggested as convenient.

Those intending to address the meeting are urged to send titles, along with a statement of time desired, and of whether blackboard, lantern or moving pictures are to be used, to Dr. E. R. Dunn, Haverford College, Haverford, Pennsylvania, *before* May 1. It is expected that this meeting will be one of the most interesting in the history of the Society, and that it will draw a large attendance.

Union of American Biological Societies

A CONFERENCE between the presidents of member societies and the Executive Committee of the Union of American Biological Societies, was held on March 7 at Washington. Dr. E. R. Dunn represented our Society, and presents the following report on the meeting:

The topics discussed were chiefly the present and future status of Biological Abstracts and of the Union of American Biological Societies. The sense of the meeting was strongly in favor of continuation of both these organizations. The question of financing both was held to be a matter of appeal to foundations (such as the Rockefeller, which is at present largely financing Biological Abstracts), and appeal to societies and to their individual members. Suggestion was made that a certain proportion of dues of members in the various societies should be turned over to the Union, to finance its occasional expenses, and the surplus from this annually turned over to Biological Abstracts. A proposition to this effect will be made to the American Society of Ichthyologists and Herpetologists at the May meetings. It was pointed out that Biological Abstracts would have great difficulty in obtaining aid from foundations unless it was more vigorously supported by individual biologists and by societies. The representatives of the American Society of Ichthyologists and Herpetologists and the President of the American Ornithological Union suggested that they, as individuals, felt rather strongly that the Zoological Record had claims on them and their societies at least equal in strength to those of Biological Abstracts.

Biological Abstracts and Zoological Record

IN connection with the foregoing report, President Dunn has presented for consideration of our members his summary of a comparative study of the Biological Abstracts and the Zoological Record for the period 1926 to 1929, inclusive. He finds that the total number of titles relating to cold-blooded vertebrates rendered accessible to students by the Zoological Record in these four years was 4622, as against 2713 in Biological Abstracts. For fishes, the Zoological Record listed 2542 titles, Biological Abstracts 1568. For reptiles and amphibians the Zoological Record listed 2080 titles; Biological Abstracts listed 1145. Thus the Zoological Record renders students in these fields approximately twice the service rendered by Biological Abstracts. The annual cost to students of these groups is: Biological Abstracts, $9.00;

Zoological Record, 6 shillings and sixpence (about $1.65). The expenditure of the Zoological Record is about $10,000 annually. Biological Abstracts costs $70,000 annually and they hope to receive $110,000 annually. Both are in financial straits, the Zoological Record operating at a loss of about $7,325 annually. Since the American Society of Ichthyologists is being asked to help finance Biological Abstracts, it seems only fitting that these facts be placed before members. Detailed figures follow.

Reptiles and Amphibians	1926	1927	1928	1929
Zoological Record	583	280	744	473
Biological Abstracts	199	237	223	486

In 1929 the 486 titles of Biological Abstracts listed 195 papers actually published in 1929; the 473 titles of the Zoological Record included 375 papers published in 1929.

Fishes	1926	1927	1928	1929
Zoological Record	556	531	657	798
Biological Abstracts	235	357	335	641

Since both Journals are in financial straits, it is to be hoped that members will consider the services rendered by them and their cost to members before voting funds for their support.

In partial defence of Biological Abstracts, the Editor would point out that this instrument has many advantages, although he believes that it supplements rather than displaces the Zoological Record. The Abstracts, of course, furnish much more information about most articles than the Record, although the index is not so handy for most of our members. The less complete covering of the literature by the Abstracts is being remedied, as shown by Dunn's own figures. The greater cost yields the abstracts of all papers in all fields of biology. The monthly issuance of the Abstracts brings in notices of papers sooner after publication than does the Zoological Record. Without doubt, however, the Zoological Record is of more service to systematists and naturalists generally than is Biological Abstracts, and is published and indexed in a much more convenient form for our use.

Meeting of the Western Division

PLANS are being made for the annual meeting of the Western Division of the American Society of Ichthyologists and Herpetologists, in conjunction with the annual sessions of the Pacific Division of the American Association for the Advancement of Science, at Pasadena, June 15 to 20. In contrast with practically all previous meetings on the Pacific coast, this is to be a meeting of the entire American Association, and a fine program and an unusually large attendance are expected. The Western Division of our Society will attempt a better showing than ever before, and especially invites eastern members to be present. A call is hereby issued for papers to be presented at this meeting. Address all communications to G. S. Myers, Stanford University, California.

New York Conference on Biological Survey

AT the invitation of Henry Morgenthau, Jr., Commissioner of Conservation, a group of New York conversationists and scientists met at Albany on March 11. The members represented a large number of New York state institutions: Conservation Department, State Museum, Buffalo Society of Natural Sciences, University of Rochester, Hobart College, Hamilton College, Rensselaer Polytechnic Institute, Syracuse University and Cornell University. Other members came from Wesleyan University and the University of Michigan, and the United States Bureau of Fisheries sent a representative. The conference was held for the purpose of discussing problems of the survey of the Black and Oswegatchie river systems proposed for 1931. This region, covering an area of 3,539 square miles, will be studied by a large staff of scientists who will report on the fish resources and upon problems involving these, and will make recommendations for stocking. This work, which is to be done in June, July, and August of this year, is a continuation of a program begun in 1926. The biological survey investigations of the Conservation Department are under the direction of Dr. Emmeline Moore.

State Fish Books

AT the Cleveland meetings of the American Association for the Advancement of Science, there was held a round-table discussion of the several proposed books now being prepared to cover state fish faunas. Those who took part were Dr. Emmeline Moore (for New York); Dr. John R. Greeley (for New York and Michigan); Prof. T. L. Hankinson (for Michigan and North Dakota); Dr. Carl L. Hubbs (for Michigan, Wisconsin and Oklahoma); Dr. Chancey Juday (for Wisconsin); Dr. Herbert R. Osburn and E. L. Wickliff and M. B. Trautman (for Ohio), and Dr. A. I. Ortenburger (for Oklahoma). Questions of desirable uniformity in treatment, and of cooperation in exchange of illustrations and information were discussed, and a satisfactory understanding reached.

A West Indian Expedition

WE learn from *Natural History* that a boat named the "Basilisk" has been built by Gilbert C. Klingel for continuing his herpetological explorations in the West Indies. This work is being done under the auspices of the American Museum.

News from Stanford Ichthyologists

DR. ALBERT W. HERRE, Curator of the Museum of Zoology at Stanford University, has left for the Philippines, where he expects to spend the next six months collecting fishes. His itinerary will cover Manila, Culion, Dumaguete, Mindanao, Sulu, and British North Borneo. He is especially interested in obtaining a series of the peculiar Cyprinidae of the Lanao Plateau in Mindanao, and he hopes to be able to do some collecting in southeastern China on his way home.

Mr. Joseph H. Wales of the Hopkins Marine Station of Stanford University, Pacific Grove, California, is to accompany the California State Fish and Game Commission's new boat, the "Bluefin", on a trip down the Mexican Coast to Mazatlan this month. Studies of the shore and pelagic fishes will be made. William A. Dill, of the same institution, is studying fish eggs and larvae and the growth of flat fishes. Leo Shapovalov is working at the Natural History Museum of Stanford on Formosan fishes.

Reptile Study Society

MISS NELLIE LOUISE CONDON, Director of the Reptile Study Society of America, New York City, reports that a large female *Heterodon platyrhinos,* captured by Charles Hewlett Hitch, Secretary of the Society, at High Hill Beach, deposited 23 eggs on July 17 and 18. Although the snake was given a choice of sphagnum moss or deep sand, the eggs were placed on the wooden floor of the cage.

New Appointments

EDWIN S. THOMAS has accepted the position of Curator of Natural History in the Ohio State Museum at Columbus.

Mr. C. W. Coates has joined the staff of the New York Aquarium, where he will have immediate charge of the collections of tropical freshwater fishes now being developed.

Dr. Olive Stull Davis, has been appointed to a National Research Fellowship for work on reptiles. Dr. Davis is monographing the family Boidae at the Museum of Comparative Zoology, Cambridge.

Reptile House, National Zoo

THE Reptile House of the National Zoological Park was formally opened in February. A description of this unique building will appear in the June number of Copeia.

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